PHYSICAL SCIENCE: CHEMISTRY & PHYSICS

Course Standards and Objectives With Activities & Labs

PHYSICAL SCIENCE

Course code: 321101

Physical Science Standards, Competencies, and Suggested Activities

COURSE DESCRIPTION

Physical Science is designed to serve as a foundation for other high school science courses. It is a laboratory course (minimum of 30% hands-on investigation) that integrates principles of chemistry and physics. It emphasizes inquiry-based learning, process skills, and higher order thinking skills. Chemistry units include composition and classification of matter, atomic structure and the periodic table, and chemical bonds and reactions, together with basic nuclear chemistry. Physics units include forces and motion, conservation of energy, electricity and magnetism, and wave phenomena, characteristics, and behavior including electromagnetic and sound waves. Because experimentation is the basis of science, laboratory investigations are an integral part of this course. Investigative, hands-on lab activities that address the high school inquiry standards are central to effective instruction in this course.

Preface:

A major objective of science instruction is to promote scientific thinking. One way to accomplish this in the laboratory is to avoid giving too much direction in experimentation. The ultimate goal would be for students to design their own experiments, including purposes, hypotheses, procedures, data collection and analysis and conclusions. A good way to lead students to this level of thinking is to begin with experiments that have clearly defined goals, but no clearly defined procedures or equipment lists. Laboratory time must then be focused on solving problems and analyzing the components of a well-designed investigation. Much of what is performed is called "guided inquiry". Students are given a final goal to achieve and little else. Students are responsible for forming hypotheses, designing procedures, choosing equipment, recording and organizing data, performing calculations, error analyses, and conclusions. Students must learn to think for themselves in order to pose scientific questions and solve scientific problems. Activities may be adapted from "cookbook" style lab manuals and an excellent resource is labs shared by experienced teachers on the internet. One excellent source with templates and rubrics for graphing, reports, projects and essays can be found on the Frontier High School website at Red Rock, Oklahoma. (http://pc65.frontier.osrhe.edu/hs/science). Sharing of ideas may also be accomplished through science list serves such as the South Carolina Science Council (SC^2) list serve.

Introduction to Physical Science / Basic science skills - Inquiry

(These activities/topics should be addressed throughout the course in every unit of study – as appropriate)

- Safety skills and procedures
- Process and Investigative skills
- Controlled experiment / variables – constants and controls
- Graphing (data collection and analysis)
- Measurement – common International Systems (SI)/metric units, derived units and formulas (conversions, simple dimensional analysis)
- Precision and accuracy
- Accurate use of standard equipment / technology (i.e. - calculators, computers, Calculator-based laboratories [CBLs], etc.) – emphasis on proper care & use of all equipment
- Calculate mass, volume, density relationships / Mathematical formulas and calculations

Standard I: Inquiry

Inquiry is not an isolated unit of instruction and should be embedded throughout the content area of Physical Science. The nature of science and technology is incorporated within this area.

A. Identify Questions and Concepts that Guide Scientific Investigations

Experimental design should demonstrate logical connections between a knowledge base and conceptual understanding.

1. Demonstrate an understanding of the process of developing scientific hypotheses (e.g. formulate a testable hypothesis based on literature research and prior knowledge, and select the correct form for a hypothesis statement based on a given scenario).
2. Identify and select experimental variables (independent and dependent) and devise methods for controlling relevant conditions.

B. Design and Conduct Investigations

Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques and safety should be used in designing and conducting a scientific investigation.

1. Demonstrate an understanding of the process of testing scientific hypotheses (e.g. design and conduct a scientific investigation based on the major concepts in the area being studied).
2. Select and use appropriate instruments to make the observations necessary for the investigation, taking into consideration the limitations of the equipment.
3. Select the appropriate safety equipment needed to conduct an investigation (e.g. goggles, aprons, etc.) and identify safety precautions for the handling of materials and equipment used in an investigation.
4. Describe the proper response to emergency situations in the laboratory.
5. Identify possible sources of error (e.g. procedural and measurement) and appropriate controls (e.g. repeated trials and systematic manipulation of variables) in an experimental design.
6. Organize and display data in useable and efficient formats, such as tables, graphs, maps, cross-sections and mathematical expressions.
7. Draw conclusions based on qualitative and/or quantitative data.
8. Discuss the impact of sources of error on experiments.
9. Communicate and defend the scientific thinking that resulted in conclusions.

C. Use Technology and Mathematics to Improve Investigations and Communications

Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the SI system is the accepted measurement system in science, opportunities to use the Customary System are encouraged where appropriate.

1. Select and use appropriate technologies (e.g. - computers, calculators, CBLs, electronic balances, calipers, etc.) to achieve appropriate precision and accuracy of data collection, analysis, and display.
2. Discriminate between valid and questionable data.
3. Select and use mathematical formulas and calculations to express and interpret laboratory measurements.
4. Demonstrate an understanding of and interpret trends and patterns in data (e.g. calculate interpolated data points and predict extrapolated data points).
5. *Draw a "best fit" curve through data points using computer software as necessary and desirable*.
6. Calculate the slope of the curve and use correct units for the value of the slope for linear relationships.
7. Perform dimensional analysis calculations.
8. Perform calculations using numbers expressed in scientific notation.

D. Formulate and Revise Scientific Explanations and Models Using Logic and Evidence.
Scientific explanations and models are developed and revised through discussion and debate.

1. Construct scientific explanations or models (physical, conceptual, and mathematical) through discussion, debate, logic, and experimental evidence.
2. Develop explanations and models that demonstrate scientific integrity. (P)
3. Revise explanations or models.

E. Recognize and Analyze Alternative Explanations and Models
Scientific criteria are used to discriminate among plausible explanations.

1. Compare current scientific models with experimental results.
2. Select and defend, based on scientific criteria, the most plausible explanation or model.

F. Communicate and Defend a Scientific Argument
Experimental processes, data and conclusions should be communicated in a clear and logical manner.

1. *Develop a set of laboratory instructions that someone else can follow.*
2. *Develop a presentation to communicate the process and conclusion of a scientific investigation.*

G. Understandings about Scientific and Technological Inquiry
Historical and current scientific knowledge, current research, technology, mathematics and logic should be the basis for conducting investigations and drawing conclusions.

1. *Analyze how science and technology explain and predict relationships.*
   a. *Defend the idea that conceptual principles and knowledge guide scientific and technological inquiry.*
   b. *Discuss how the available body of scientific knowledge, historical and current, influences the design, the interpretation, and the evaluations of investigations.*
2. Discuss the reasons scientists and engineers conduct investigations and the methods they use to conduct investigations.
3. Demonstrate and discuss the use of technology as a method for enhancing data collection, data manipulation, and advancing the fields of science and technology.
4. Discuss how mathematics is important to scientific inquiry.
5. Discuss why scientific models and explanations need to be based on the available body of scientific knowledge.
6. Understand that scientific explanations must be logical, supported by the evidence, and open to revision.

Pre-Chemistry UNIT: Composition and Classification of Matter
(Elements/Compounds, Solids/Liquids/Gases, Solutions & Solubility, Acids/Bases, Organic Compounds)

Code	SC Standard	Performance Objectives (Competencies)	Suggested Activities & Labs
	Elements/Compounds		
II.B.3.a	a. Compare and contrast elements and compounds.	• Given examples of substances, classify as elements or compounds based on chemical and physical properties	• Rotation Lab – Lab stations with examples to classify • LAB Physical & Chemical properties and changes
	Solids/Liquids/Gases		
II.B.5.a	a. Compare and contrast solids, liquids, and gases in terms of particle arrangement and the energy that binds them together.	• Given examples of solids, liquids, and gases, describe their characteristics including the spacing of the particles relative to their energy.	• Illustrate, label and explain particle arrangements and movement in solids, liquids, and gases.
	Solutions & Solubility		
II.B.4.b	b. Identify factors that affect the rates at which substances dissolve.	• Recognize the factors of temperature, surface area, and stirring that affect the rate at which various substances dissolve.	• Design and conduct an experiment to determine which factors increase the rate at which a substance dissolves (heating/cooling, stirring, crushing).
II.B.4.c	c. Compare the ratios of solute to solvent in concentrated and dilute solutions in relation to the physical properties of the solution (e.g. conductivity, melting point depression).	• Given a solute and a solvent, discuss the differences in the preparation of a concentrated and dilute solution. • Compare the conductivity of a concentrated solution with a dilute solution of a common substance. • Given data of a concentrated and dilute solution, analyze the effect of the solute on the melting point depression of the solution.	• Prepare some simple concentrated and dilute solutions of tea, juice, or Kool-aide. • Measure the conductivity of a concentrated salt solution and a dilute salt solution. • Provided a table of sample data of melting point depression of various concentrations, graph the results and analyze the effect of the solute on the melting point of the solution at different concentrations.
II.B.4.d	d. Analyze the behavior of polar and nonpolar substances in forming solutions.	• Examine why a substance will dissolve in one solvent but not in another.	• Using a variety of polar and nonpolar substances, predict their ability to form a solution.

	Acids/Bases a. Differentiate between acids and bases.		
II.C.3.a.1	a.1. Identify the physical and chemical characteristics of acids and bases including their formulas and reactions with metals, and pH.	• State the physical and chemical properties of common acids and bases. • Given a chemical formula, recognize whether the substance is an acid or a base. • Recognize the common product of a reaction between an acid and a metal.	• Construct a table comparing and contrasting acids and bases including their formulas. • Given a list of chemical formulas, recognize the identifying group (H or OH) and classify as acid or base. • Identify the gas product released and write a balanced chemical equation for when a metal such as aluminum or magnesium is reacted with an acid, such as hydrochloric.
II.C.3.a.2	a.2. Determine the pH ranges and strengths of acidic, basic, and neutral solutions using appropriate instruments and indicators (e.g. pH meters, CBL probes, universal indicators).	• Describe pH as a way to measure the strength of acids and bases. • Determine the pH of a variety of substances of unknown pH using indicators of varying pH ranges.	• Review the pH scale with regard to range for acids and bases, then draw a pH scale with common examples with regard to strong and weak acids and bases. • Create solutions of various pHs using water and a selected acid and base. • Determine the pH of common household substances using a variety of indicators (phenolphthalein, litmus paper, pH paper, cabbage juice, universal indicator, or appropriate tools such as a CBL probe and pH meter).
II.C.3.a.3	a.3. Explain how acid rain is formed and discuss its effects on the environment. (P)	• Describe the causes of acid rain and how it is formed in the atmosphere. • Discuss the consequences of acid rain on the environment.	• Research the issue of acid rain and prepare a report/presentation on the topic – include causes, formation, and consequential effects on the environment.
II.C.3.a.4	a.4. Demonstrate an understanding of the significance of pH as related to consumer products.	• Examine different consumer products and relate the importance of their pH to their application.	• Place consumer products with predetermined pH on a pH scale; recognize the classification groups such as fruits, soaps, cleaners, body products, antacids, etc.

	Organic Compounds		
II.B.6.a	a. Demonstrate an understanding of how carbon atoms bond to one another as simple hydrocarbons.	• Examine carbon bonding of simple hydrocarbons (single, double, triple bonds).	• Make models of simple hydrocarbons to demonstrate single, double, and triple bonding
II.B.6.b	b. Describe the formation of polymers.	• Examine the creation of polymers from smaller structural units.	• Recognize from structural formulas that subunits (monomers) make up common polymers such as plastics, rubber, and synthetic fibers.
II.B.6.d.	d. Determine the uses of polymers in everyday life. (P)	• Cite examples of common polymers and their uses (plastics, rubber, synthetic fibers).	• Research some examples common polymers such as various plastics, natural and synthetic rubber, and synthetic fibers, giving their everyday uses.
II.B.6.c	c. Discuss the importance of polymers as biological compounds such as proteins, carbohydrates, and lipids.	• Identify the roles of proteins, carbohydrates, and lipids in living organisms.	• Make a chart relating biological polymers (proteins, carbohydrates, lipids) to their characteristics and roles in living things.

Pre-Chemistry UNIT: Atomic Structure and the Periodic Table

Code	Standard	Performance Objectives (Competencies)	Suggested Activities & Labs
	Atomic Structure		
II.A.1.a	a. Trace the historical development of the model of the atom, including the contributions of John Dalton, J.J. Thomson, Ernest Rutherford, and Neils Bohr. (H, N)	• Sequence atomic models in their development and determine how each scientist used information from preceding models to further the atomic theory.	• Design pictures to portray models on a timeline showing ideas of each scientist and discuss factors influencing the growth of models. Research each scientist (internet), design a poster and share his contribution to form the illustrated timeline. • Power-point presentation available on http://pc65.frontier.osrhe.edu (Frontier website). • Using marbles and a sponge hidden under a large cardboard square, design a way to determine the shape of the hidden object. Relate this experience of indirect evidence to Rutherford's alpha particle bombardment of gold foil in which he discovered a nucleus.
II.A.1.b	b. Compare and contrast the component particles of the atom.	• Compare and contrast the mass, location and charge of each major subatomic particle.	• Construct a table and interpret data from the table comparing and contrasting protons, electrons, and neutrons. (Ex: Which particles make up most of the mass of an atom?) • Make models of atoms.
II.A.2.a	a. Trace the development of nuclear models, including the contributions of Marie and Pierre Curie, Lise Meitner, and Enrico Fermi. (H, N)	• Analyze and sequence the changes in the model of the nucleus through the contributions of Marie and Pierre Curie (*radioactivity discovery*), Lise Meitner (*fission-spitting the nucleus*), and Enrico Fermi (*chain reaction-release of tremendous energy*). (H, N)	• Using the Internet, research the contributions of Marie and Pierre Curie, Lise Meitner, and Enrico Fermi, producing a time line of their accomplishments related to nuclear models.
II.A.2.b	b. Identify the charge, component particles and mass of the nucleus.	• Identify the charge and relative mass of protons and neutrons.	• Research the charge and mass of the nucleus. Discuss what is the charge of the nucleus as a whole (positive) and relate it to the charge of the atom as a whole (neutral).

II.A.2.c	c. Recognize that elements exist as isotopes, which may be stable or unstable (radioactive).	• Identify stable unstable (radioactive) isotopes of elements	• Make models of isotopes of different atoms (suggested model materials – plastic Easter eggs with BBs or beads, pennies). Compare masses of isotopes of the same element and construct a table of comparison. • Identify where most radioactive isotopes of elements are found on the Periodic Table.
II.A.2.d	d. Demonstrate the understanding that the number of protons identifies the element and is the same for all atoms of that element.	• Explain that the number of protons identifies the element and is the same for all atoms of that element.	• Determine the element when given the number of protons.
II.A.3.a	a. Compare and contrast fission and fusion reactions, showing how they are processes that convert matter to energy.	• Differentiate the conversion of matter into energy during fission and fusion reactions.	• Using visuals as models, explain the basic differences between fission and fusion. Construct a table or Venn diagram to compare and contrast fission and fusion.
II.A.3.b	b. Describe fusion as the process that fuels the sun and other stars.	• Identify and explain fusion as the process that fuels the sun and other stars.	• Make and label a student-designed diagram of the steps of the fusion process that converts hydrogen to helium.
II.A.3.c	*c. Demonstrate an understanding of the consequences of the development of nuclear applications, such as the atomic bomb, nuclear power plants, and medical technologies. (P)*	• Explore the environmental impact and medical uses of nuclear applications.	• Research and debate the various nuclear applications as related to their positive and negative consequences.

	Periodic Table		
II. B.2.a	a. Trace the historical development of the periodic table including the contribution of Dmitri Mendeleev. (H, N)	• Identify the contributions that led to the present-day periodic table.	• Research Dmitri Mendeleev's development of the periodic table and further contributions of later scientists to the construction and arrangements of the table.
II.B.2.b	b. Explain the arrangement of elements within a group on the periodic table based on similar physical and chemical properties.	• Sort elements into various groups/families on the periodic table according to their physical and chemical properties.	• LAB Investigate the chemical behavior in the reaction of elements of similar groups. (For example react Group 1 & 2 elements with ammonium phosphate and ammonium carbonate and observe whether precipitation occurs.)
II.B.2.c	c. Explain that property trends on the periodic table are a function of the elements' atomic structures.	• Describe similarities and differences between elements within a given period or group on the periodic table.	• Observe and investigate visuals/diagrams for periodic trends – make predictions Groups – valence electrons, size of atoms, reactivity levels Periods – metallic & nonmetallic properties, number of energy levels, ascending atomic number
II.B.2.d	d. Determine atomic number, mass number, the number of protons, the number of neutrons, and the number of electrons for given isotopes of elements using the periodic table.	• Use the atomic number and mass number of an isotope of an element to determine the number of protons, neutrons, and electrons.	• Given a periodic table, determine the number of subatomic particles in the isotopes of given elements.

Pre-Chemistry UNIT: Chemical Bonding and Reactions

Code	Standard	Performance Objectives (Competencies)	Suggested Activities & Labs
	Bonding		
II.B.1.a	a. Determine the charge a representative element will acquire based on its outer electron arrangement.	• Determine the ionic charge an atom will acquire if it gains or loses electrons.	• Use models or electron dot diagrams to show how electrons are gained or lost when ions are formed.
II.B.3.b	b. Classify compounds as being ionic or covalent on the basis of the transferring or sharing of outer electrons.	• Describe the processes that form ionic and covalent bonds. • Give examples of ionic compounds and covalent molecules.	• Use models with representative bond connections to make examples of ionic and covalent substances. • Given a list of compounds, determine ionic and covalent compounds based on their type of bonding (transfer or sharing).
II.B.3.c	c. Determine the ratio by which elements combine to form ionic compounds and express that ratio in a chemical formula.	• Using oxidation numbers, determine chemical formulas for ionic compounds.	• Use the compound name and oxidation numbers to write a chemical formula for ionic compounds.
II.B.4.a	a. Relate the physical properties (e.g. boiling point, melting point, conductivity) of compounds to their ionic or covalent bonding.	• Differentiate between ionic and covalent substances based on their physical properties.	• LAB Properties of ionic and covalent compounds (ex. Melting point, conductivity)

	Chemical Reactions		
II.C.2.a	a. Investigate and provide evidence of a chemical change by recording systematic observations, such as change in color, odor, and temperature for various chemical reactions. (N)	• Identify characteristics that indicate that a chemical reaction has taken place. • Conduct investigations involving chemical change.	• LAB Checking Out Chemical Changes – design several activities where substances are combined. Look for a change in the product(s) and give evidence during the reaction that a chemical change has taken place. • Find examples of chemical changes in everyday life and give evidence that the change was chemical.
II.C.2.b	b. Recognize balanced chemical equations.	• Show the parts of a chemical reaction. • Describe the characteristics of a balanced equation.	• Determine the reactants and products in a chemical equation from a list of sample equations. • Prove that an equation is balanced by determining the number of atoms of each element in the reactants and the products.
II.C.2.c	c. Classify reactions as energy absorbing (endothermic) or energy releasing (exothermic) on the basis of temperature measurements.	• Distinguish between endothermic and exothermic reactions.	• LAB "Hot Pack/Cold Pack" – combine various designated substances and measure the temperature or feel the container for evidence of an increase or decrease in temperature.
II.C.1.d	d. Conclude from experimental evidence, based on mass measurements, that mass is neither created nor destroyed during ordinary chemical reactions (e.g. balance simple synthesis and decomposition equations, conduct mass measurements before and after reactions). (N)	• Conduct an investigation to understand the Law of Conservation of Mass in chemical reactions. • Perform the task of balancing simple synthesis and decomposition equations.	• LAB Showing Conservation of Mass in a Chemical Reaction – find the mass of all reactants on a balance; combine reactants in a closed system; find the mass of the products; Compare. (Example – Alka-seltzer in a sealed container) • Determine whether a chemical equation is balanced using total mass of reactants and products. • Practice balancing chemical equations (synthesis and decomposition).

II.C.1.a	a. Understand the process of rusting in terms of electron transfer (e.g. determine the number of electrons lost or gained, write and balance chemical equation for rusting, and discuss the economic impact of rusting).	• Determine the charge on the iron and oxygen in the rusting reaction on the basis of electrons lost or gained. • Write and balance the synthesis reaction for rusting. • Identify ways to prevent rusting. • Discuss the economic impact of rusting.	• Draw the electron dot diagram for iron III and oxygen and determine the valence number for each. • Combine Iron III and oxygen gas (O_2) in a written chemical equation that produces rust (Fe_2O_3). • Identify materials/products made from iron and determine preventative measures against rusting (bring in samples/pictures where possible); discuss how the economy would be affected if these sample items were allowed to rust.
II.C.1.c	*c. Explain the sources and environmental effects of some inorganic and organic toxic substances, such as heavy metals and PCBs. (P)*	• Identify the major sources of toxic organic and inorganic substances and their effect on the environment.	• Research on the Internet (e.g. EPA website and other environmental governing agencies) and report on the industrial, mining, and manufacturing sources of PCBs (polychlorinated biphenyls) and heavy metals, such as lead and mercury. Describe their effects on the environment and public health.
II.C.4.a	a. Demonstrate an understanding of how reaction rates are a function of the collisions among particles (e.g. effects of temperature, particle size, stirring, concentration on reaction rates; and catalysts on reaction rates).	• Explain how temperature, particle size, stirring, and concentration affect the rate of a reaction. • Demonstrate the effect of a catalyst on the rate of reaction.	• Design and perform an experiment to determine how temperature, particle size, stirring, and concentration affect the rate of a reaction. • Using two glow sticks, put one in hot water and the other in cold water, graph how the reaction rate is linked to temperature. • Use a catalyst such as manganese dioxide or potassium iodide, to speed up the decomposition of hydrogen peroxide. Using a control without a catalyst, compare rates of reaction.
II.C.4.b	*b. Apply reaction rate concepts to real life applications such as food spoilage, storage of film and batteries, digestive aids, and catalytic converters. (P, T)*	• Describe how factors that affect reaction rates be used to speed up/ slow down reactions in everyday situations (food spoilage, film storage, battery storage, digestive aids, catalytic converters).	• Produce a chart of real life applications of reaction rate including the following headings: application, example, desired reaction rate (speed up or slow down), how to accomplish this rate change.

	b. Demonstrate an understanding of how metabolism is an inter-related collection of chemical reactions.		
II.C.1.b.1	b.1 Understand that food is composed partially of large complex molecules that are broken down into simpler molecules. (P)	• Demonstrate an understanding of how food is changed into simpler forms in chemical digestion.	• Demonstrate how the starch molecules in a cracker are broken down into sugar by enzymes in saliva (sweetened taste as an unsalted cracker is slowly chewed) • Demonstrate the digestion of starch using an iodine test and a Benedicts test.
II.C.1.b.2	b.2 Analyze how these simpler molecules are rearranged into new molecules within living things. (N)	• Analyze how simple sugars combine to form glycogen, starch, or cellulose. • Explain why many different proteins can be formed from just a few amino acid groups.	• Make models differentiating a monosaccaride, disaccaride, and polysaccaride. • Make a model illustrating the difference between an amino acid, a dipeptide, and a polypeptide.

Pre-Physics UNIT: Motion and Forces

Code	Standard	Performance Objectives (Competencies)	Suggested Activities & Labs
III.A.1.a	a. Trace the historical development of the understanding of forces, including the contributions of Galileo, Isaac Newton, Benjamin Franklin, and Charles-Augustin de Coulomb. (H,N)	• Identify different kinds of forces. • State how Galileo and Isaac Newton developed greater understanding of gravitational force. • Explain Benjamin Franklin's ideas concerning the behavior of forces between opposite charges. • Give Coulomb's explanation of how distance between charges affects the strength of electrical force.	• Design a concept map of different forces including (by description/pictures) common examples of these forces. • Research the contributions of Galileo and Isaac Newton, and prepare a time-line/ presentation of this information as related to gravitational force. • Research and explain Benjamin Franklin's idea of positive and negative electrical charges. • Research and simply state Coulomb's law (emphasis is not mathematical but put the relationship into words).
	Motion		
III.A.1.b	b. Predict the motion of an object in terms of Newton's first law (inertia).	• State and investigate the meaning of Newton's first law of motion related to inertia and give examples.	• LAB Use equipment (toy cars, balls, etc.) to show the relationship of inertia to mass. • Give examples of the effects of inertia on objects that start or stop moving quickly.
III.A.1.c	c. Identify and investigate the factors that affect acceleration in terms of Newton's second law (F = ma).	• Explain the relationship between force, mass, and acceleration. • Calculate problems related to Newton's second law (F = ma)..	• Using equipment, such as dynamic carts, show how the variables of force and mass affect the acceleration of an object. • Use automobile visuals to define acceleration: Accelerator/gas peddle = speed up Brake = slow down Steering wheel = change direction • Using derived units and formulas, solve for force, mass, or acceleration in problem situations related to Newton's second law. (F = ma)

III.A.1.d	d. Evaluate the effects of action/reaction in terms of Newton's third law.	• Analyze the action force and reaction force and their affects on the two objects involved in the interaction. • For several examples illustrating Newton's third law, demonstrate the correct use of the relationship for momentum, ($m_1v_1 = m_2v_2$) . • Given three of the four variables, calculate the fourth, $m_1v_1 = m_2v_2$	• Simulate and analyze situations involving action force and reaction force on complementary pairs of objects. • Solve for the momentum of two objects given the mass and velocity of these objects (p = mv). Compare these momentums and identify the action and reaction.
III.A.1.e	e. Generate and interpret graphs of linear motion.	• Collect, organize, and display distance, time, and speed data in the form of a table. • Construct, label and interpret distance-time and speed-time graphs from collected data.	• Measure the distance and time that it takes an object (marble, tennis ball, cart) to roll down a sloped surface or move a designated distance (like a person on a track); calculate the average speed of the object. • Based on data collected from investigations or provided in a table, construct and label a line graph with appropriate variables. (opportunity to use CBLs)
III.A.1.f	f. Cite examples of Newton's laws that are common in everyday life (e.g. using seat belts, diving from a boat, pushing a swing). (P, T)	• Evaluate the role of safety belts in relation to various motions of a car and its passengers (1^{st} law). • Describe how changing the force pushing a swing or the mass on a swing affects the motion of the swing (2^{nd} law). • Relate the motions of a boat and a diver to action/reaction forces (3^{rd} law).	• Role play the motions of a passenger with and without a seat belt in a car as the car accelerates (slower, faster, or changes direction). • Describe other examples of Newton's second law, relating the effects of changing force and mass, comparing them changing the force pushing or the mass of the person being pushed on a swing. • Demonstration: Allow a student in a rolling chair to throw a ball forward and observe that the student rolls backward. • Evaluate other examples of Newton's third law identifying action/reaction forces comparing them with a person diving from a boat.

	Gravitation		
III.A.2.a	a. Describe changes in gravitational attraction in terms of changes in distances between masses and in terms of changes in masses.	• State the effect of changes in distance between masses on the gravitational attraction of two objects. • State the effect of changes in mass on the gravitational attraction of two objects. • Explain how mass differs from weight.	• Design a graphic illustrating the effects that distances have on two objects gravitationally attracted to each other. • Choose two planets in the solar system and illustrate how gravitational attraction is affected by the distance from the sun. • Research the gravitational attraction on man if he travels to different objects in the solar system. • Role play and describe how a sporting event would be different if played on the moon rather than on Earth.

Pre-Physics UNIT: Conservation of Energy and Electricity

Code	Standard	Performance Objectives (Competencies)	Suggested Activities & Labs
	Energy Transformations		
III.B.2.a	a. Classify energy types as potential, kinetic, or electromagnetic.	• Classify the types of energy as either potential or kinetic. • Describe the energy as contained by a field such as electromagnetic waves.	• Generate practical examples of energy and classify them as potential or kinetic. • Demonstrate the field surrounding an electric current and a magnet.
III.B.1.a	a. Analyze transformations between potential and kinetic energies.	• Given the highest and lowest vertical positions of a moving object, identify the variations in kinetic and potential energy at both points.	• LAB Label the position of an object as it changes height (pendulum, roller coaster) to show energy transformation.
III.B.1.b	b. Analyze transformations among other forms of energy such as heat, light and sound, and mechanical, electrical and chemical energy.	• Examine and diagram specific types of energy transformations.	• Make a list of various energy transformations common to the home and school environment. Construct a diagram or flowchart of these transformations.
	Work and Machines		
III.B.1.c	c. State and apply quantitative relationships among energy, work, power, and efficiency.	• Describe the relationship between energy and work done, work and power, and work and efficiency. • Calculate mathematical problems related to work, power, and efficiency.	• Given common examples, pictorial or verbal, determine how work is related to energy, power, and efficiency. • Use appropriate formulas and units to calculate work, power, and efficiency from given or generated data (simple machines, motors, stair-climbing activities).
III.B.1.d	d. Understand and apply the principles of mechanical advantage (e.g. contrast the two forces and two distances that produce mechanical advantage when a machine is used to produce work).	• Identify where effort/input force and resistance/output force are applied in simple machines to produce mechanical advantage. • Recognize the effect on mechanical advantage if the effort/input or resistance/output force is changed or if the effort/input or resistance/output distance is changed.	• Set up a demonstration lab using different simple machines, such as a lever or pulley, to show effort/input and resistance/output forces and to compare effort and resistance distances.

	Kinetic Theory/ Gas Laws/ Heat Energy		
III.B.3.b	b. Describe particle motion and distance as the phase changes from *solid* to *liquid* to gas.	• Describe the effect of heat energy on particle movement during phase change in terms of energy and particle distance.	• Interpret a graph of phase changes generated from data collected from a Phase Change Lab (Ice to Steam). • Make a visual representation of the phase changes describing the particle motion and distance in each phase.
III.B.3.a	a. Predict and measure the effects of varying the temperature, pressure, and volume of gases (e.g. balloon studies, the bends in divers, and the hazards of handling and storing pressurized gases). (N)	• Analyze data that relate temperature and volume – Charles' law. • Analyze data that relate pressure and volume of a gas – Boyle's law. • List and evaluate the hazards of handling and storing pressurized gases.	• Model and diagram Charles' law using balloons on a flask, warming and cooling the air. • CBL lab on pressure. • Using calibrated syringes (50 cc) model, measure, and diagram the effect of changing volume on the pressure of a gas (air). Boyle's law • SAFETY LAB / demonstration/video: Refer to Materials Safety Data Sheets (MSDS) to determine precautions and safety procedures for handling and storing pressurized gases.
III.B.4.a	a. Demonstrate an understanding of the transfer of energy from hotter to cooler objects by conduction, radiation, and convection.	• Compare and contrast the transfer of thermal energy by conduction, convection, and radiation in terms of particle movement and types of matter.	• Create a chart to include the types of heat transfer, the particle movement, the matter involved, and examples of each. • Demonstrate the three types of heat transfer. • Given the type of heating system, identify the method of heat transfer as conduction, convection, or radiation.

	Electricity		
III.A.3.a	a. Demonstrate the interactions of like and unlike charges by examining changes in electrostatic attraction in terms of changes in distance between two point charges.	• Determine how like and unlike charges interact. • State the relationship of the effect of distance on the strength of attraction between two point charges.	• Investigate how like and unlike charges interact and the effect of distance on this interaction (examples: include friction rod activities, pith balls, balloons, glass and amber rods with fabric, effects on an electroscope).
III.A.3.b	b. Demonstrate an understanding of the production and effects of static electricity (e.g. its role in disruptions and damage to electrical devices, destruction of property and life, everyday annoyances such as static cling). (N, P, T)	• Explain how static electricity is produced. • Explain what happens when there is a build-up of charge. • Explain and draw how lightning is produced and discharges. • Discuss the effects of static electricity on electrical devices, and clothes dryers.	• Discuss the effects of static electricity produced from lightning on appliances and the effect of power lines on disruption of cell phones and radios. • Draw and explain the production of static electricity in situations as lightning strikes, clothes clinging in a dryer, and dust build-up on a television.
III.A.4.a	a. Demonstrate an understanding of the relationship between electricity and magnetism (e.g. describe how moving electrical charges produce magnetic fields, describe how moving magnets produce electrical fields).	• Explain the relationship between a magnetic field and electric current. • Give examples of how moving electrical charges produce magnetic fields or how moving magnets produce electrical fields.	• Investigate how electricity can produce magnetism (electromagnets). LAB: Changing coils of wire for strength of electromagnet LAB: Compasses around a wire with current flowing to show field • Investigate how magnetism can produce electricity (generators and motors). Use Genecons – hand-held generators
III.A.5.a	a. Demonstrate an understanding of simple series and parallel circuits. (e.g. construct, compare, contrast, and schematically diagram simple series circuits and parallel circuits).	• Assemble, investigate and draw diagrams of series and parallel circuits. • Compare and contrast series and parallel circuits in terms of the ways current and potential are distributed in them.	• Construct series and parallel circuits that will turn on light bulbs. Sketch a diagram indicating which bulbs will light under different conditions. Diagram the path(s) for current to follow and the changes in potential/voltage throughout each type of circuit. • Justify applications of each type of circuit.

III.A.5.b	b. Describe the meaning of voltage and amperage.	• Explain why charges are able to move through a circuit – voltage. • Describe how the flow of charge is measured – amperage.	• Relate the voltage in a battery to the difference in charge between the positive and negative ends. • Model, using meters, that when a potential difference exists between two regions, current will flow.
III.A.5.c	c. Perform calculations using Ohm's Law.	• Given two of the following three variables: current, resistance, and potential difference (voltage), calculate the third variable by applying Ohm's Law.	• Determine through student designed investigations whether increasing the voltage in a circuit will increase the current in that circuit. • Solve mathematical problems related to the factors in Ohm's Law.
III.A.5.d	d. Explain how fuses, surge protectors, and breakers function. (T)	• Describe how the safety devices in circuits work and explain the role of each.	• Provide examples of fuses, surge protectors, and breakers, and discuss how they work. • Use a bimetallic strip to demonstrate how a circuit breaker works. • Relate the number of amps to the thickness of the wire in fuses. • Discuss the dangers of using pennies to replace fuses. • Invite an electrician to discuss this topic. • Discuss how the role of a surge protector is different from a fuse and a circuit breaker.
III.C.4.a	a. Understand and compare the functions of insulators, conductors, and semiconductors.	• Differentiate between electrical conductors, insulators, and semiconductors based on their ability to allow the movement of electrons.	• Design an experiment that will investigate the conductivity property of materials. • Relate the ability to move electrons to an element's position on the periodic table.
III.C.4.b	b. Evaluate the impact of miniaturization of electric circuits upon individuals and society. (H, P, T)	• Examine the effects of the advent of computers, cell phones, palm pilots, and other technologies on the individual and society.	• Debate or evaluate the significance of miniaturized circuits in your personal life and your community.

III.A.4.b	*b. Examine the effects of the advent of electricity on individuals and society.* *(H,N,P,T)*	• Contrast life before and after the introduction of electricity in a home and in the community.	• Interview people who lived prior to the introduction of electricity and share the results of these interviews with the class. • View video "Pushing Back the Darkness" (Santee Cooper) and provide a written evaluation of the effects of the introduction of electricity to South Carolina. • Describe the effects of power failures on individuals and society.
III.B.4.b	*b. Compare and contrast the environmental impact of power plants that use fossil fuels, water, or nuclear energy to produce electricity. (P, T)*	• Evaluate the advantages and disadvantages of the use of alternative sources of energy and analyze their effect on the environment.	• Research and debate the environmental impact of various sources of energy. • Visit a power plant or invite guest speakers to discuss the advantages and disadvantages of alternative fuel sources.

Pre-Physics UNIT: Wave Characteristics and Behavior

Code	Standard	Performance Objectives (Competencies)	Suggested Activities & Labs
III.C.1.a	a. Identify and show relationships among wave characteristics such as velocity, period, frequency, amplitude, and wavelength using the formula, $v = f\lambda$.	• Recognize the properties of waves that include amplitude, wavelength, frequency, and speed. • Describe the relationship between period and frequency. • Given two of the following variables: velocity, frequency, and wavelength, calculate the third using the formula, $v = f\lambda$.	• Use a long, coiled spring to demonstrate the wave characteristics. • Observing diagrams of waves traveling at different frequencies, determine the effect of frequency on period. • Solve for frequency, wavelength, or velocity in given wave problems.
III.C.1.b	b. Compare and contrast models of longitudinal waves (e.g. sound waves, seismic *"P"* waves) and transverse waves (e.g. electromagnetic waves, water waves).	• Categorize waves as either transverse or longitudinal (compressional). • Relate sound, seismic, light, and water waves to the two types of waves.	• Create longitudinal (compressional) and transverse waves in springs or slinkys. Determine the effect the waves have on the medium. (Student investigation) • Draw a diagram of a transverse light wave and a longitudinal sound wave labeling the properties – crest/trough or compression/rarefaction, amplitude, and wavelength of the wave.
III.C.1.c	c. Distinguish among electromagnetic spectrum, seismic waves, water waves, and sound waves on the basis of their properties and behaviors.	• Differentiate between various types of waves as to the wave category, properties, and behaviors (such as movement through a medium, speed, reflection/refraction/polarization)	• Make a chart/concept map of the classification, properties, and behaviors of each type of wave including examples.

III.C.1.d	d. Demonstrate an understanding of factors affecting wave energy (wavelength, amplitude, and frequency) and its effects on everyday life (e.g. health issues, medical diagnostics and treatments).	• Explain amplitude and frequency or high and low energy waves. • Examine the negative effects of wave behavior on the human body and the contributions of waves to medical and dental examination, diagnosis, and treatment.	• Use a coiled spring to investigate amplitude and frequency; change the force on the spring to change the amplitude and frequency – note the effects. • Use different pitched tuning folks and a pan of water to investigate how wave energy is related to wave frequency. • Research recent developments in the cause and treatment of wave-related diseases. • Invite guest speakers from the medical profession to discuss health issues, medical diagnostics and treatment that depend on waves.
III.C.2.a	a. Compare and contrast the parts of the electromagnetic spectrum in terms of velocity, wavelength, frequency and energy using the formula, $v = f\lambda$.	• Order the waves in the electromagnetic spectrum according to wavelength, frequency, and energy. • State the relationship between speed, frequency, and wavelength of electromagnetic waves as they travel through a given medium.	• Make a sketch of the electromagnetic spectrum. Label and analyze the forms of energy according to wavelength, frequency and energy. Give common applications for different areas of the spectrum. • Given a chart of the frequency and wavelength recognize that the speed of electromagnetic waves in a vacuum is a constant, 3.0×10^{16} km/s.
III.C.3.a	a. Understand how releasing of energy by electrons produces light (e.g. fireworks, neon lights, florescent lights, and halogen lights).	• Explain the energy transformations as the electrons change energy levels. • Explain how neon, florescent, and halogen lights work.	• Research the production of light at the atomic level. • Research the various light bulbs (neon, florescent, and halogen) to determine how each produces light. • LAB Flame Test – Relate the results of these tests to fireworks and to a method to identify metals.